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MULTISCALE RESERVOIR CHARACTERISTICS OF THE TENSLEEP FORMATION, SOUTH CASPER CREEK FIELD, NATRONA COUNTY, WYOMING.

by

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ABSTRACT

Reservoir characterization requires an integrated multidisciplinary evaluation of the reservoir rocks. This research involves the geological analysis and description of the South Casper Creek, Wyoming, reservoir in terms of sedimentological architecture, facies, and tectonic overprint (i.e., faults and fractures). Studies include quantification of reservoir preperties, such as porosity, permeability, mineralogy, pore network, grain size, sorting, and flow units. Reservoir attributes occur at various scales and require different levels of observation. Ultimately, this study was designed to provide an enhanced perspective on fluid-flow behavior and its controlling effects on reservoir performance.

Mesoscale characteristics describe and determine reservoir core and log properties within the context of sedimentary facies, petrophysical characteristics, tectonic overprints, and their related reservoir quality measurements (i.e., porosity and permeability). The main reservoir of the Tensleep Formation is the Upper Unit Sandstone lithofacies, which is subdivided into 5 zones, A-E, on the basis of first-order bounding surfaces, porosity, and permeability. This upper unit is a typical inland fine-grained eolian deposit. Dune and interdune are the two common depositional systems, and their distinct permeability modes are controlled internally by specific stratification types such as grainflow, wind-ripple, interdune, and

interstratification among grainflow, wind-ripple, and interdune. Although on a microscopic scale these systems are distinctive, on a field-wide scale the reservoir quality varies within each system reflecting diagenetic variations. Minor permeability variation characterizes the second-, and third-order bounding surfaces. Major reservoir heterogeneity is associated with the first-order bounding surfaces, especially if these surfaces coincide with interdunal pond deposits and/or extensive thin wind-ripple laminae.

Fracture pattern analysis from surface outcrop study depicts three different orientations. Fracture systems with predominantly N86°E direction are prevalent on the east flank, those with N45°W direction occur on the crest, and N15°W and east-west fractures occur on the west flank. These fractures are mainly gouge-filled and healed. The fractures tend to compartmentalize the reservoir and act as partial horizontal flow barriers. Elsewhere, the presence of minor faults may enhance fluid transmissivity. There is no significant rotation of these fracture systems after their formation.

Evaluation of flow units and the field-wide megascale (interwell and field domains) permeability and porosity variations of these Tensleep reservoirs provides insight on lateral and vertical heterogeneity of permeability. These analyses involve determinations of the Dykstra-Parsons heterogeneity measure, coefficient of variation, and power-normal probability distribution function of the reservoirs. Zones B and D have the best hydrocarbon storage and producibility, although internally they are moderately homogeneous. Zone C is the most homogeneous reservoir, although it does not have the highest porosity and permeability. Zones E and A are the poorest reservoirs with low reservoir storage, low producibility, and the most heterogeneous permeability.

Microscale evaluation of the Tensleep reservoirs is concerned with controls on the fluid flow behavior within the grain and pore domains. Grain size sieve analysis and pipette analysis reveal that the fine-grained component exhibits a linear relationship with permeability and porosity (a higher percentage of this component correlates with better reservoir quality), whereas the presence of coarse to medium sand, very fine sand, silt, and clay fractions in the rock correlate with reduced reservoir quality. Size fraction cut-off values are presented for estimating good to excellent, moderate, poor, and nonreservoir quality rocks. Permeability anisotropy between grainflow stratification and pin-stripe interlaminations is indicated by highly variable pore geometries, variation in mineral contents, and heterogeneous grain size fractions. Very low porosities within interdune lithofacies potentially act as flow barriers.

The various scales of reservoir characterization employed at South Casper Creek field increase our capability for predicting and managing hydrocarbon production in eolian reservoirs.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ENCLOSURES

Note: * Because all of the well names start with the word UNION, for simplicity purposes, in the text these names will be reduced without using UNION. For example UNION10-6-3 USA will be written as USA10-6-3.